

Short Communications

Preparation and Characterization of Poly Vinyl Acetate Nanofiber Doping Copper Metal

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Electrospinning is a very simple and versatile process by which polymer nanofibers with diameters ranging from a few nanometers to several micrometers (usually between 50 and 500 nm) can be produced using an electrostatically driven jet of polymer solution (or polymer melt). Significant progress has been made in this process throughout the past few years and the resultant nanostructures have been exploited to a wide range of applications. This work concerns preparation of poly vinyl acetate Nanofiber doping Copper by using Electrospun Technique to use in different applications. The surface morphology of poly vinyl acetate Nanofiber doping Copper was investigated by SEM and Chemical changes have been performed through characterization followed by using FTIR, TGA analysis.

Keywords: Electrospinning, Polymer, nanofibers

1. INTRODUCTION

Polyvinyl acetate (PVAc) is often used as a carrier polymer for preparation of inorganic nanofibers. Such inorganic nanofibers are not prepared directly, but through organic nanofiber precursor. The precursor nanofibers are usually fabricated by technology of electrospinning from PVAc solution together with appropriate well thermally decomposable metal salt. This precursor is then calcined when inorganic nanofiber or nanowhiskers are formed [1, 2]. Nanomaterials made of pure metals or their oxides are prepared according condition of calcination. This new inorganic

materials are promising for application in area of semiconductors [3, 4]. The technology of electrospinning is one of the most used methods to prepare ultra-thin fibers [5-9]. Electrospinning is a simple and versatile method for generating ultrathin fibers from a rich variety of materials that include polymers, composites and ceramics [10–18]. This nonmechanical, electrostatic technique involves the use of a high voltage electrostatic field to charge the surface of a polymer solution droplet and thus to induce the ejection of a liquid jet through a spinneret Figure (1). In a typical process, an electrical potential is applied between a droplet of a polymer solution, or melt, held at the end of a capillary tube and a grounded target. When the applied electric field overcomes the surface tension of the droplet, a charged jet of polymer solution is ejected. The route of the charged jet is controlled by the electric field. The jet exhibits bending instabilities caused by repulsive forces between the charges carried with the jet. The jet extends through spiralling loops; as the loops increase in diameter the jet grows longer and thinner until it solidifies or collects on the target [19–24]. In the case of a melt the discharged jet solidifies when it travels through the air and is collected on the grounded metal screen. The following parameters and processing variables affect the electrospinning process [14,15,25]: (i) system parameters such as molecular weight, molecular weight distribution and architecture (branched, linear, etc.) of the polymer, and polymer solution properties (viscosity, conductivity, dielectric constant, and surface tension, charge carried by the spinning jet) and (ii) process parameters such as electric potential, flow rate and concentration, distance between the capillary and collection screen, ambient parameters (temperature, humidity and air velocity in the chamber) and finally motion of the target screen. For instance, the polymer solution must have a concentration high enough to cause polymer entanglements yet not so high that the viscosity prevents polymer motion induced by the electric field. The solution must also have a surface tension low enough, a charge density high enough, and a viscosity high enough to prevent the jet from collapsing into droplets before the solvent has evaporated. Morphological changes can occur upon decreasing the distance between the syringe needle and the substrate. Increasing the distance or decreasing the electrical field decreases the bead density, regardless of the concentration of the polymer in the solution. Applied fields can moreover influence the morphology in periodic ways, creating a variety of new shapes on the surface. In addition to creating round nanofibers, electrospinning a polymer solution can produce thin fibers with a variety of cross-sectional shapes. Branched fibers, flat ribbons, ribbons with other shapes, and fibers that are split longitudinally to form larger fibers have been observed [26, 27].

In this article, poly vinyl acetate nanofiber doping copper metal has been prepared from poly vinyl acetate solution and Copper sulfate cellulosic. In the part of characterization, different characters were evaluated FTIR and TGA analysis provided proved for the occurrence of his process while the homogeneity of the formed nanofiber was examined by SEM analysis.

2. EXPERIMENTAL

2.1. Electrospinning

Poly vinyl acetate was dissolved in dimethylformamide (DMF) at room temperature (RT) under moderate stirring for 48 h to form a homogeneous solution then add the solution of copper. The

total solution concentration was fixed to 14 wt.-%.the solution was filled in a 20 mL NORM-JECT Luer Lok tip plastic syringe having an 18 gauge stainless-steel needle with 90° blunt end. The electrospinning setup included a high voltage power supply, purchased from the NanoNC, Inc. (S. Korea), and a nanofiber collector of aluminum foil that covered a laboratory produced roller with the diameter of 10 cm. The collector was placed at 14 cm tip to collector distance (TCD). During electrospinning, a positive high voltage of 20 kV was applied to the needle; and the solution feed rate of 0.5 mL/h was maintained using a KDS 200 syringe pump purchased from the KD Scientific Inc. (Holliston, MA). The electrospun poly vinyl acetate Nanofiber doping Copper could be readily peeled off from the aluminum foil and the obtained nano-fibrous was stored in a desiccator before the subsequent surface functionalization Figure (1) .

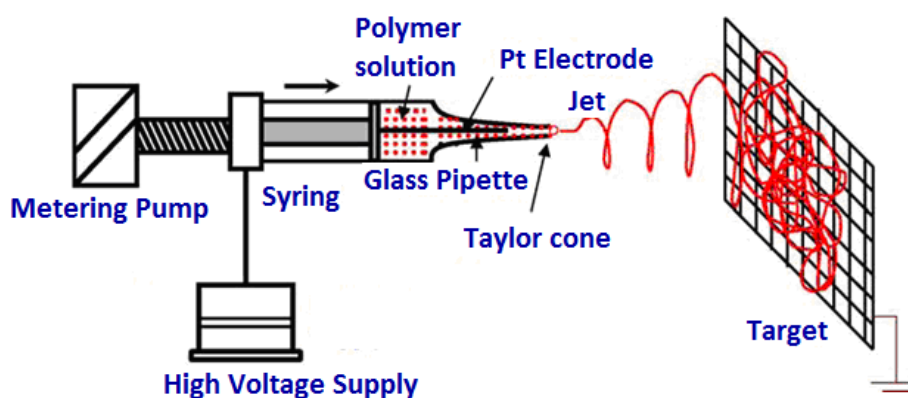


Figure 1. Schematic of the electrospinning apparatus utilized to electrospin solutions.

2.2. Thermogravimetric analysis (TGA)

The thermal degradation behaviors of poly vinyl acetate Nanofiber doping Copper were studied with a thermogravimetric analyzer (TA Instruments, Q500 TGA, United States); instrument in the temperature range from 20 °C to 800 °C under nitrogen at a flow rate of 40 ml/min and at a heating rate of 10 °C/min.

2.3. Scanning electron microscopy (SEM)

The morphology of electrospun nanofibers was studied by a scanning electron microscope (JEOL GSM-6610LV) after copper doping at an accelerated voltage of 10 kV. The fracture surfaces were vacuum-coated with platinum for SEM.

2.4. FT-IR Spectroscopic Analysis.

The structure of poly vinyl acetate Nanofiber doping Copper was analyzed by FT-IR spectra. Powder Samples were mixed with KBr to make pellets. FT-IR spectra in the absorbance mode were

recorded using FT-IR spectrometer, and fiber sample were measured by sensor (Bruker, TENSOR Series FT-IR Spectrometer, Germany), connected to a PC, and analysis the data by IR Solution software, analytical methods are standard in OPUS TM software.

3. RESULTS AND DISCUSSION

3.1. Electrospinning of poly vinyl acetate Nanofiber Containing Copper.

The PVAc powder in dimethyl formamide (DMF) with the weight percent of PVAc/DMF of 15%. The mixtures were then stirred at room temperature until a clear and then add the solution of copper until the solution completely soluble .viscous precursor solution was obtained. The solution was filled in a 30mL BD Luer-Lok™ tip plastic syringe having an 18 gauge stainless-steel needle with 90°C blunt end.

3.2. Characterization

3.2.1. Scanning Electron Microscope Analysis

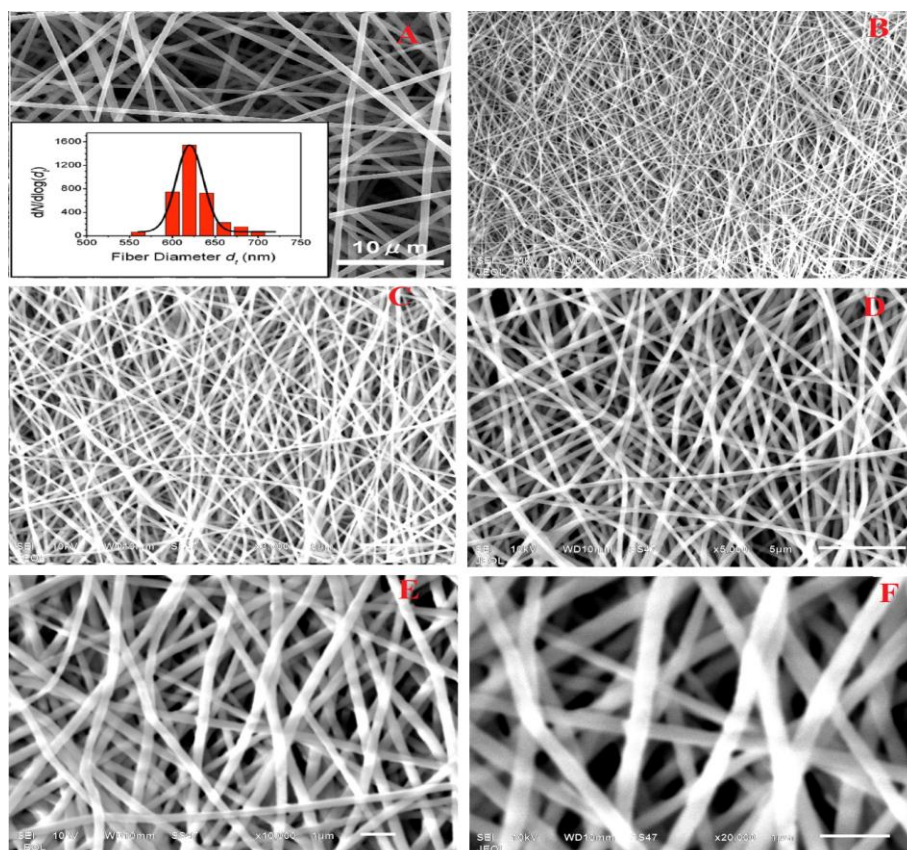


Figure 2. SEM micrograph of (A) original poly vinyl acetate nanofiber (B) poly vinyl acetate nanofiber doped copper [X1500] (C) poly vinyl acetate nanofiber doped copper [X3000] aminated, and (D) poly vinyl acetate nanofiber doped copper [X5000] (E) poly vinyl acetate nanofiber doped copper [X10000] (F) poly vinyl acetate nanofiber doped copper [X20000] .

The morphology of electrospun poly vinyl acetate Nanofiber Containing Copper shows in figure (2). It is clear from this Figure that no phase separation has been observed and the homogeneity of the obtained Nanofiber can be easily observed and the doping of copper has been proved and it is clear the diameter of poly vinyl acetate Nanofiber Containing Copper is smaller than vinyl acetate Nanofiber.

3.2.2. Infrared spectrophotometric analysis

Using the procedure described earlier, in situ FT-IR was performed on virgin PMMA and its nanocomposites. The spectra collected at early stages of degradation figure (3) are identical to that of monomeric MMA, as expected. Moreover, no significant changes in the spectra appear over the course of degradation (spectra not shown here), suggesting that no new functionalities are evolved

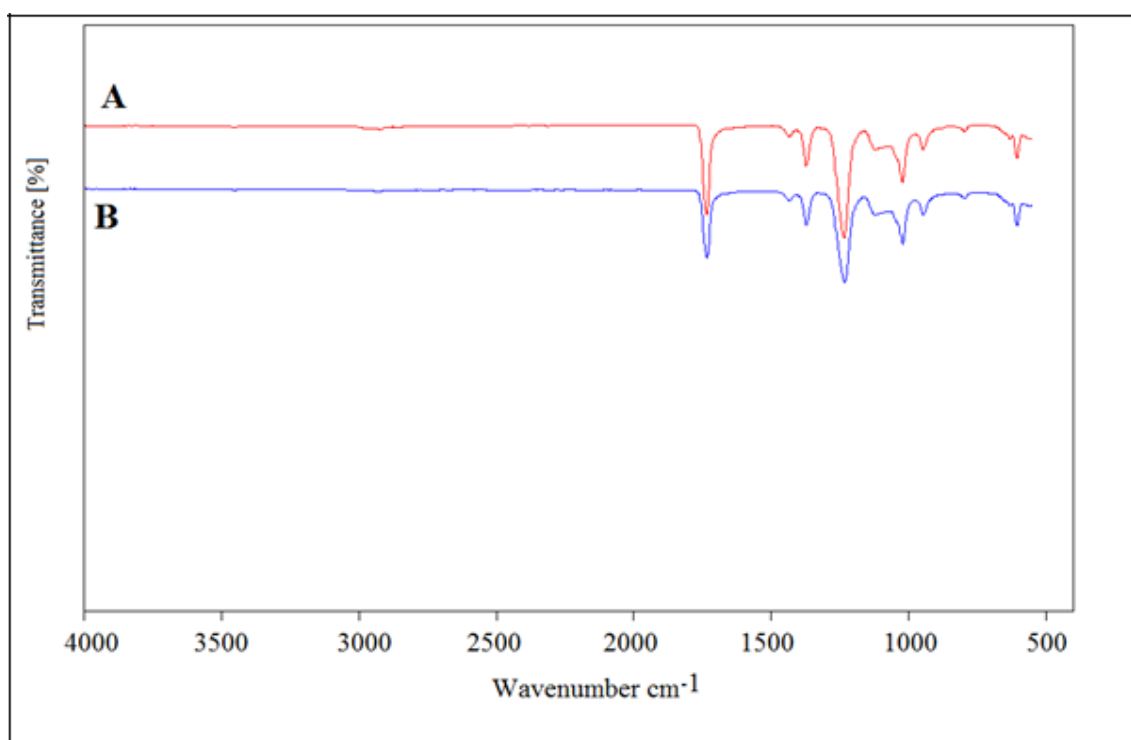


Figure 3. FT-IR Spectrum of: Poly vinyl acetate Nanofiber (A) and Poly vinyl acetate Nanofiber Containing Copper (B).

3.2.3. Thermogravimetric analysis (TGA)

The thermal degradation behaviors of poly vinyl acetate Nanofiber doping Copper were studied with a thermogravimetric analyzer (TA Instruments, Q500 TGA, United States); instrument in the temperature range from 20 °C to 800 °C under nitrogen at a flow rate of 40 ml/min and at a heating rate of 10 C/min. Thermal analysis of the poly vinyl acetate can show in figure 4(a, b, c). Thermal

analysis of the poly vinyl acetate Nanofiber without Copper and with doping copper were carried out by a thermogravimetric analyzer in a nitrogen atmosphere at a heating rate of 10 °C/min figure (5).

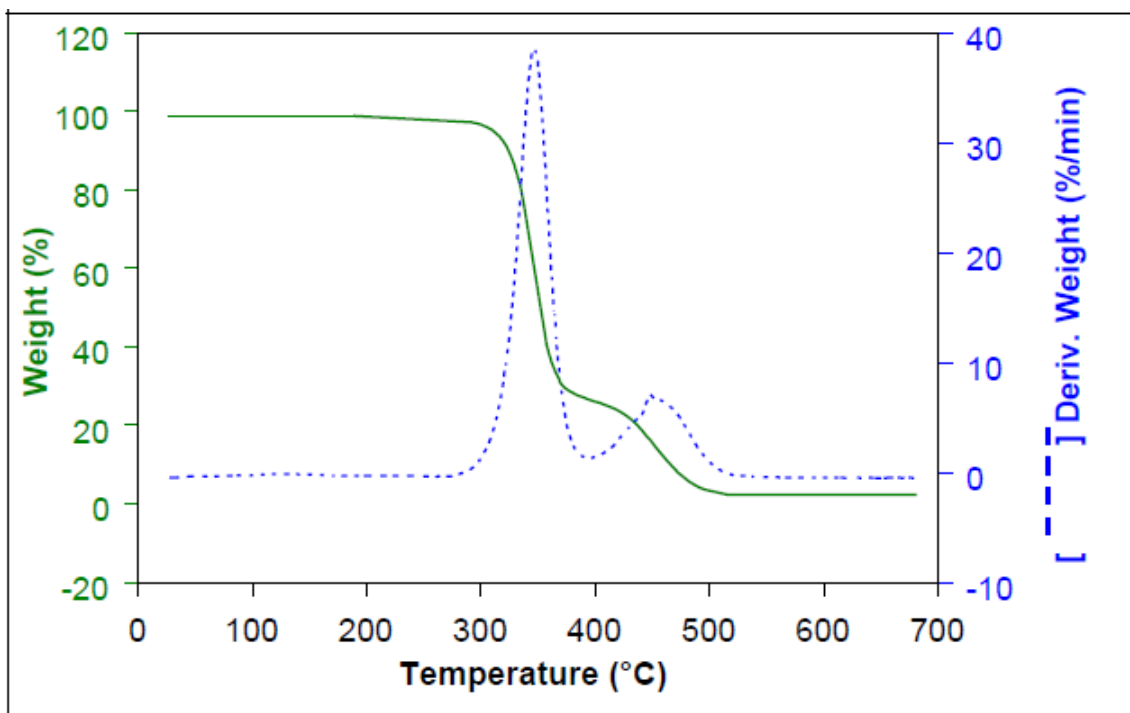


Figure (4 a).Thermal analysis of the poly vinyl acetate

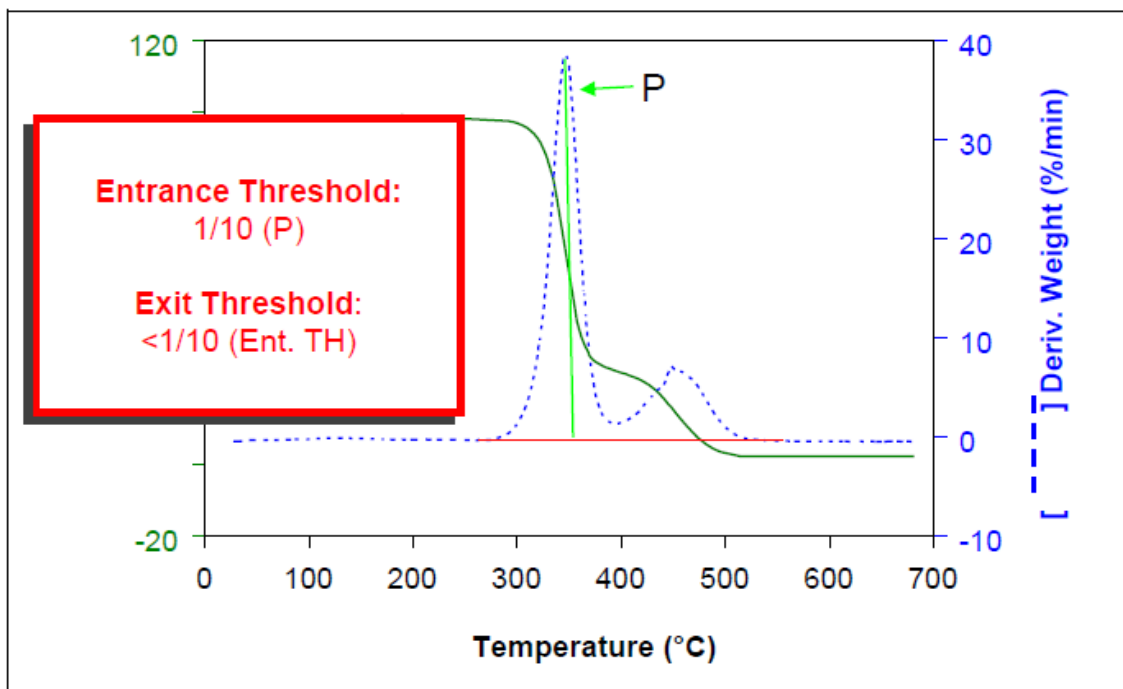


Figure (4 b).Thermal analysis of the poly vinyl acetate

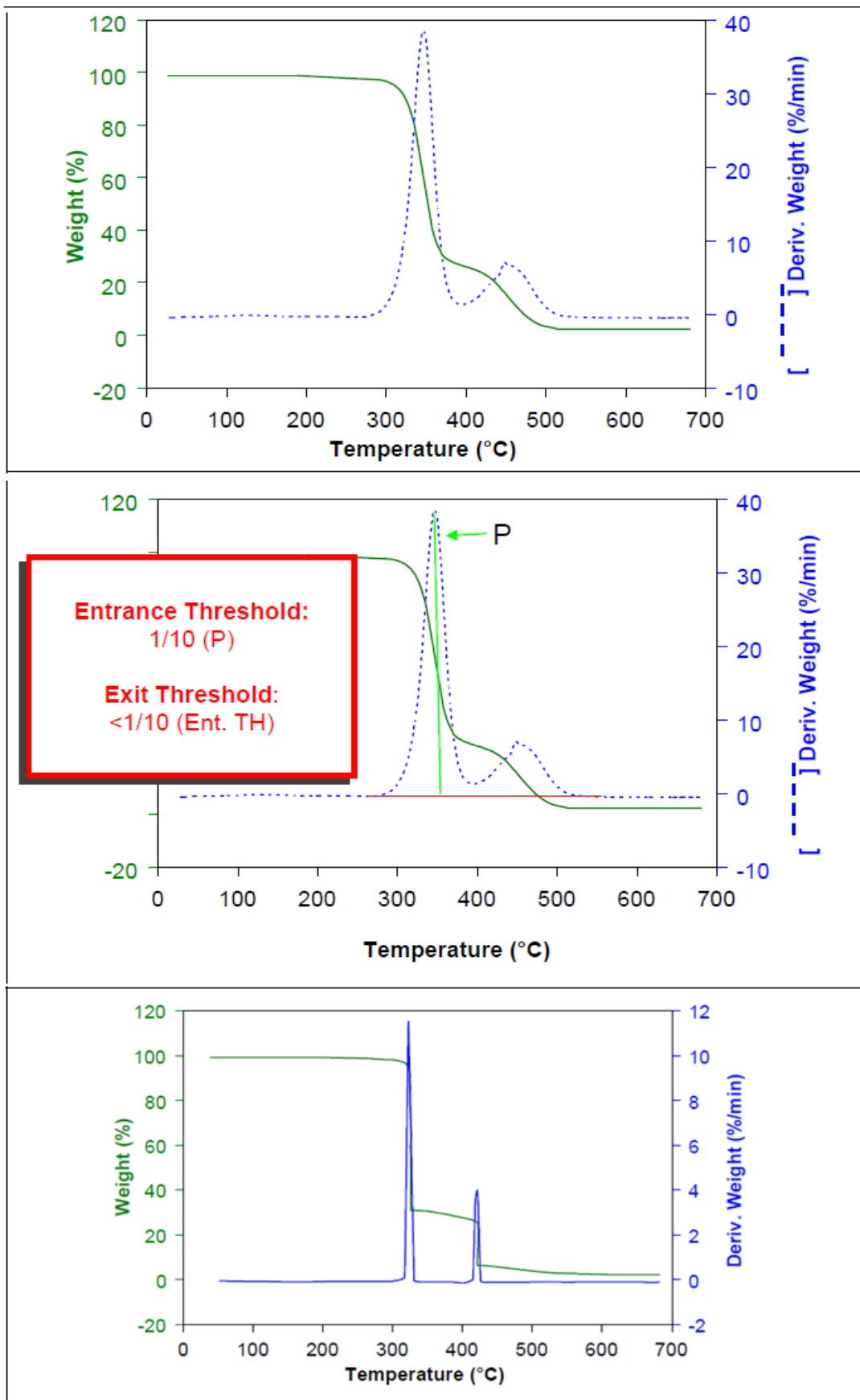


Figure (4 C).Thermal analysis of the poly vinyl acetate

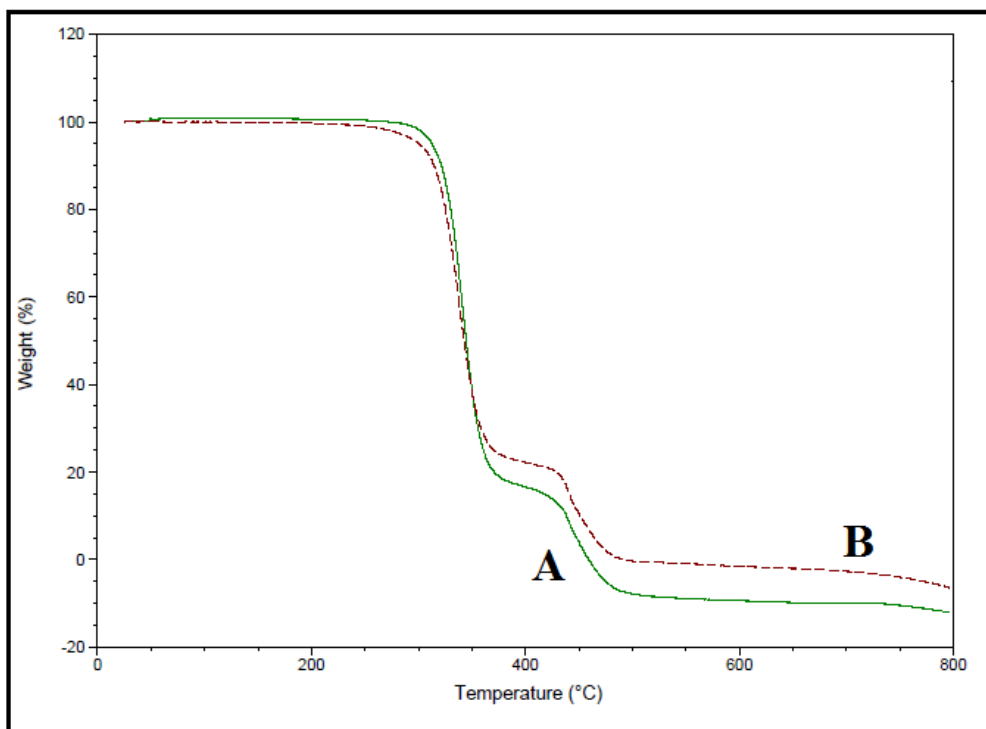


Figure 5. TGA Thermographs of: Poly vinyl acetate Nanofiber (A) and Poly vinyl acetate Nanofiber Containing Copper (B).

It was abstracted from TGA that poly vinyl acetate Nanofiber without Copper and with doping copper had two consecutive weight loss steps due to the thermal decomposition. The first was in the temperature range 280–380 °C, and the second was in the temperature range 420–500°C and it is clear the poly vinyl acetate Nanofiber doping Copper is more than stable poly vinyl acetate Nanofiber without Copper. In general, poly vinyl acetate Nanofiber doping Copper increased its thermal stability.

4. CONCLUSION

Poly vinyl acetate Nanofiber doping Copper is prepared by using Electrospun Technique to use in different applications. The surface morphology of poly vinyl acetate Nanofiber doping Copper was investigated by SEM and Chemical changes have been performed through characterization followed by using FTIR, TGA analysis. And in the future work we can use Poly vinyl acetate Nanofiber doping Copper in different applications.

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